DETERMINATION OF GLYCOGEN CONTENT DURING THE METAMORPHOSIS OF THE MEALWORM (TENEBRIO MOLITOR LINNÆUS)*

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Many students of insect metamorphosis have reported a steady decrease in glycogen during the pupal period. Bataillon (1893), Vaney and Maigon (1905) and Kotake and Sera (1909) showed irregular but progressive decreases during the metamorphosis of the silkworm, *Bombyx mori.* Similar results were obtained by Weinland (1906) for the blowfly, *Calliphora vomitaria*; Strauss (1911) in the honeybee, *Apis mellifica*; Rudolfs (1926) for the tent caterpillar, *Malacosoma americana* and Courtois-Drilhon (1931) for three species of Lepidoptera (*Attacus pernyi, Sphinx liqustri,* and *Saturina pyri*). However, Ludwig and Rothstein (1949) found that in the Japanese beetle, *Popillia japonica* there was a decrease in the glycogen content during the early part of the pupal stage, followed by a significant increase between the fourth and fifth days of pupal life at 25° C. This increase was then followed by a steady decrease during the remainder of this stage.

Evans (1934) studied the changes in nitrogen, fat and total carbohydrate during the metamorphosis of the mealworm, *Tenebrio molitor* at 25° C. At this temperature, pupal life lasts 9.5 days. He assumed that all the carbohydrate was glucose and on the basis of experiments performed at intervals of 48 hours, he found that the total carbohydrate content fell steadily throughout metamorphosis. However, Evans failed to include determinations on glycogen and up to the present time, to the writer's knowledge, no studies on glycogen have been made using this insect.

The purpose of the present study was to determine the changes in glycogen content of *T. molitor* during metamorphosis, and also

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to ascertain whether these changes involve a progressive decrease as found by some workers or whether a synthesis occurs during part of the pupal stage as reported by Ludwig and Rothstein (1949).

OBSERVATIONS AND RESULTS

The results are given in Figure I. The values plotted in each

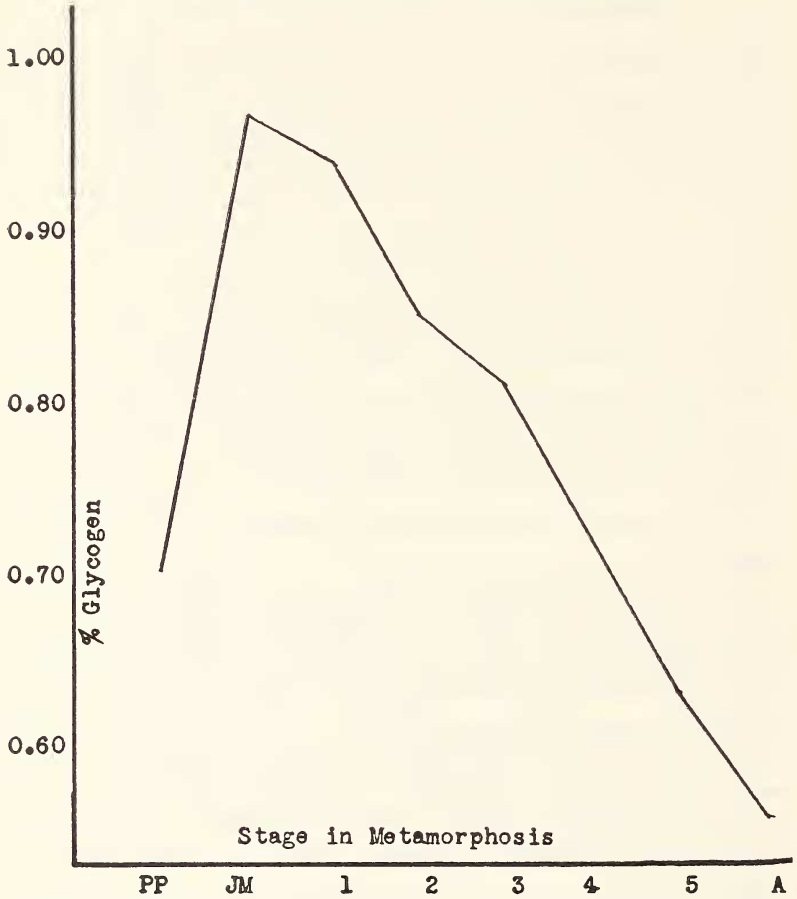

Fig. 1. Changes in glycogen during the metamorphosis of the mealworm. PP, prepupa; JM, just molted pupa; A, adult. Numbers indicate days of pupal stage.

case are averages of 10 individual tests. There was a considerable variation in the weights of different insects at the same

stage of metamorphosis. Since the amount of glycogen is greater in larger insects, the average percentage values for each determination were plotted. The glycogen content increased from 0.71 in the prepupal stage to 0.97 percent in the newly-molted pupa. During the pupal stage there was a gradual and progressive decrease, the percentage values reaching 0.64 in 5-day pupa and 0.57 in newly-emerged adults.

A statistical analysis was made of these results. Two means are said to be statistically significant when their difference divided by the standard error of the difference is equal to 2 or more. Marked changes in the amount of glycogen occur where this value is attained. This statistical analysis showed that there were significant changes between successive days of the pupal period with the exception of the newly-molted to 1-day pupa and 2-day to 3-day pupa. A weight loss accompanies the emergence of the adult, but it is not sufficiently great to cause an increase in the percentage concentration of glycogen.

SUMMARY

Determinations were made on the glycogen content of the mealworm *Tenebrio molitor* at the following stages of metamorphosis: prepupa, newly molted, one, two, three, four and five day old pupæ, and newly emerged adults.

Glycogen content rises from 0.71 percent in the prepupa to 0.97 percent in the newly molted pupa. During the pupal period there is a steady decrease in the glycogen content, continuing through the emergence of the adult.

The increase in glycogen associated with pupation corresponds to the decrease in fat content reported by Evans (1934) and hence it appears probable that this glycogen is synthesized from fat.

These results indicate the utilization of glycogen for energy during the pupal stage.

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Dr. Williams found, in the course of his investigations, that *Culicoides* breeds in certain species of sedges. Control measures would include the use of "weed-killers" for killing off the sedges or bulldozing the sedges to bury them beneath the surface. It was brought out in subsequent discussion that *Culicoides* requires a blood meal before it can successfully oviposit.

The meeting adjourned at 9:25 P.M.

LOUIS S. MARKS, *Secretary*

MEETING OF APRIL 21, 1953

A regular meeting of the Society was held at the American Museum of Natural History, President Clausen in the chair. There were thirteen members and two guests present. The minutes of the preceding meeting were accepted as read.

The speaker of the evening was Mr. Chris Olsen who in two series of Kodachrome slides illustrated his method of plastic construction of a Lampyrid beetle and of a mosquito. Intriguing was the use of a green light, attached to an electric timer to simulate the flashing in the firefly. Mr. Olson's account was very well received.

Mrs. Alice Hopf then demonstrated models of a butterfly and a spider made by her entomologically-minded son for a puppet show. The spider is to be the villain.

The meeting adjourned at 9:30 P.M.

LOUIS S. MARKS, *Secretary*

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